Videography Looks At:

A Computer-Animation Dream Machine

by Willard Thomas

Visualize a new video production system that we can use to create the visual effect we want when we want it. Just what we've always needed.

Gone would be the waits for the art shop to turn out a logo or design. When we want a visual sequence we type in the commands and turn dials and knobs to shape it just like we want it.

Gone would be the discussions about what it should look like and what might look good. Our picture would come instantly on the screen. If we want to change it, we change it. The visual with our changes appears in a fraction of a second. If the color, size or shape isn't right, we keep modifying it by turning dials or knobs.

Gone would be the waits for animated film sequences to get back from the lab. We would create with scientific accuracy any movement, sequence or effect we want, and view instantly. Again, if it isn't right, we change it.

Gone would be the need for trial and error in trying to visualize the dimensionality of a scientific or artistic concept. Instead of days of discussions and roughs we could bring the expert down to the studio and let him or her play with the image on the screen until it looks and feels right.

While we are visualizing, let's make this system powerful enough to create visual effects that we have had only in dreams. Let's also make it responsive and flexible enough that we can have both scientific accuracy and artistic flexibility. Let's also make it so simple to use that people don't have to be engineers or computer scientists to make it make pictures.

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While we are at it, we might as well make the system fun to use and interesting to play with.

As we conclude our visualization of this dream machine, we realize that we have created a production system so powerful that it can be used for live performances as well as production. It would be a complex instrument that could be used to make visual music or write visual poetry. It would even add some new dimensions and forms to the field of video art.

All this sounds highly useful and extremely interesting. It is. However, like many new things we hear about in the video field, it also sounds very complicated, very expensive and very far in the future. It isn't.

A system that does all the things we visualized, and more, is alive and making educational tapes and performing before live audiences in the Circle Graphics Habitat at the University of Illinois at Chicago Circle (UICC).

The system is a synergistic cohabitation of computer and television technology. It can be built anywhere from existing hardware for about the cost of a full blown quad recorder. Thanks to the skill of its designers, the system is easy to learn and use. My 14-year-old son was calling up pictures and moving them around after watching me for less than an hour, and he was having fun.

The pictures created are multidimensional. Experienced users have different opinions about the number of dimensions; all agree, however, there are at least six—length, width and height, plus the fourth, which is sequential movement on time, and the fifth and sixth, which are chrominance and luminance.

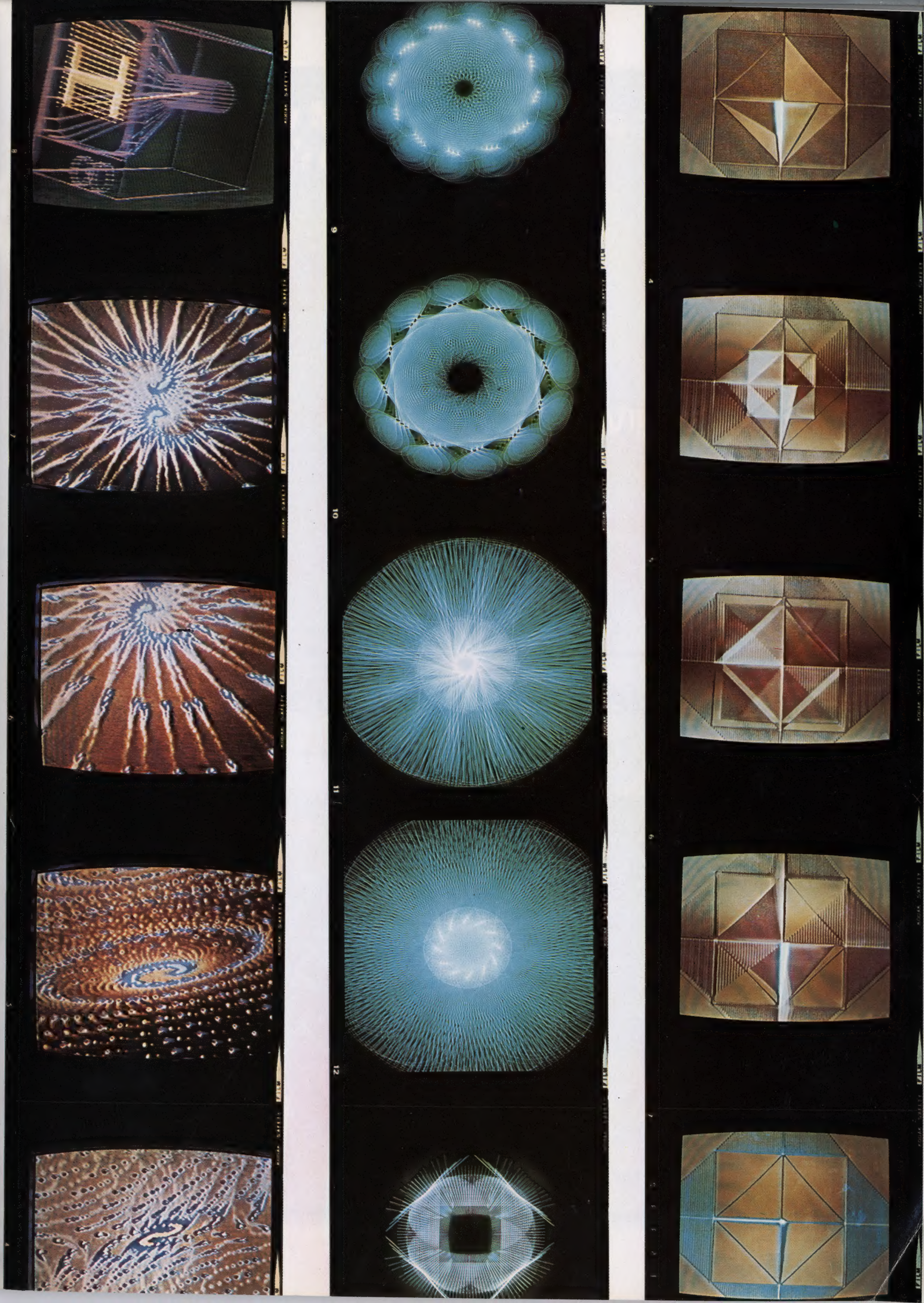
The system sends so much visual information at you and at such speed that it keeps you looking. It also allows you to change the information in such fast and understandable ways that a user, even a new one, begins to enjoy creating immediately. The entire process is so information-rich and so adapted to human ways of acting and reacting that it is at the cutting edge of man-machine interface.

Yes, the system is fun to use and it plays like a visual instrument, but it is not a toy. The research and design were funded for very serious goals by such groups as The National Science Foundation, The Carnegie Corporation of New York, the Sloan Foundation, the Graham Foundation, the National Endowment of the Arts, the Illinois Art Council and the Victor General Corporation.

The system was purchased by and is housed in the chemistry department at UICC. The head of the department, Dr. Bill Segar, wanted to begin to produce educational videotapes that would help students visualize chemical structures and concepts.

Today, the system is used by educators, scientists and artists as well as by students. One of its primary advantages is that it can be used by

Opposite page: images created by the DeFanti-Sandin computer-animation system. The top-left picture is of an educational simulation showing how tv works that was created by Dan Sandin and Phil Morton. The four lower pictures of the left-hand column are a series from "Spiral Ryral," a five-minute video work performed in Chicago in April, 1976, and created by Tom DeFanti, Sandin and Morton, with music by Bob Snyder. The imagery is based on aspects of a Fibonacci spiral moving in three dimensions. The center column shows objects rotating in three-dimensional space, all black-and-white, created in 1976 by Guenther Tetz. On the right-hand column: computer graphics, with Tetz doing the digital and Morton on the analog. Another GRASS image appeared on the cover of last month's Videography showing computer-animation renditions of the gyrations of dancer Rylan Harris.



people who are experts in things other than video production or computer technology. The instant feedback and electronic processing are so rich in both value and interest that people are standing in line to get their work done.

Before getting into a brief description of how the system was designed and how it works, let's look at the hardware involved. The system is built from:

1. A Victor General 3DI cathode ray tube with dials, light pen and electronic tablet. This device sells for about $60,000 and draws lines from points fed to it from the minicomputer.

2. A PDP II 145 minicomputer with desk unit and input keyboard. This unit sells for about $30,000 and performs the computations needed to make pictures.

3. A Sandin Image Processor. This unit is custom-built from plans available at UICC. The unit complete (and there are 15 around) would cost about $12,000 including parts and labor. (Most image processors are built by artists themselves from plans provided by the designer.)

4. Video equipment including four inexpensive ($250) Hitachi-Shibaden cameras, two Sony 2850's with editing attachments ($13,000) and assorted cables, monitors and other equipment ($1,500).

The system can be broken down into three subsystems. The PDP-II Computer is the digital origination component. The image processor and monitors are the analog processing component. The video recorders and editor are the third component.

Why do these work so well together to provide an artistic, educational tool with the features we have mentioned? The answer is the foresight and skill of the systems' creators and the soundness of the design principles.

The two primary designers are Tom DeFanti and Dan Sandin, both now professors at UICC. Each started work on a major component before either had met. Working miles apart and in different academic disciplines, both developed concepts that later combined into the powerful system at the Circle Graphics Habitat. Tom, a young Ph.D. in computer science, developed the computer language that controls the digital origination component. Tom's language is called GRASS (Graphics Symbiosis System).

GRASS is a flexible, multilevel computer language that provides users with both power and an easy-to-learn code. For those who understand computerese, it is an extensible, interpretative, yet compilable language that uses tree and stack data structures in a way that relieves the user of rigid syntax and excessive housekeeping. For those who don't dig data talk, it is a language that provides easy-to-learn commands, allows combining processes so that one doesn't have to do anything more than once and uses computer power to conserve people power.

For example, let's say we were working with a starch molecule that we have named STARCH. If we wanted to call the stored data from the disk where it is stored, make it larger or smaller and rotate it so we could see the interrelations, the commands in GRASS would be:

GETDISK STARCH
SCALE STARCH, DO
MOVE STARCH, D1
ROTATE STARCH, Y, D2

With these simple commands we could get the picture on the screen, scale it on dial 0 and move it on dial 2 and rotate it around the Y (vertical) axis using dial 2. This example also points out part of the system's power. The movements, locations, speed and angle of movement are controlled by dials. Instead of trying to compute the mathematical location we want to move STARCH to, we just turn the

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dial until it looks right. The instant feedback and capability of changing things with dials and other devices are the features that separate GRASS from other digital computer graphic concepts and systems.

The other designer, Dan Sandin, is a nuclear physicist and designer who teaches and practices art. Dan designed the image processor which is the analog processing component.

The image processor is a powerful and versatile instrument for manipulating video signals and producing effects that many experienced video directors have never seen nor even dreamed of.

The device is a set of analog modules that respond in specific ways to properties of well-behaved, high-speed electronic video signals. The modules separate, amplify, contour, extract edges, do separation effects, key superimpose, and any and all combinations of the above. It can perform the functions of a colorizer, switcher, keyer, special-effects generator and almost any other television processing instrument. However, it can combine and multiply these effects in a truly visually unique manner.

Like GRASS, the image processor was built to be used. Dan originally built the processor as a teaching machine to help his students learn electronic visualization through real-time, hands-on creation. Effects were created by connecting standard cubes to selected modules and turning knobs to get the desired color and effect.

An essential feature of the image processor is that no combination of interconnections can damage the system. This allows for free experimentation in combining effects without fear of slowing integrated circuits or power supplies.

How did these two designers working separately create systems that complemented each other? Both were developing their common but powerful design goals. A book could be written on each of these goals, but let's briefly list them.

Flexity Is Better Than Fixity. When a choice between designing for a fixed process or one with options, choose the latter.

Feedback Is Better Now Than Later. People learn and create from instant feedback. The system sacrifices half-tone image quality available in some systems (Like the General Electric Genegraphics system) and the line-pass resolution available in film or print to get feedback now. To get the same creative subtlety in dynamic visual art that we expect in music, instant feedback is not needed—it is essential.

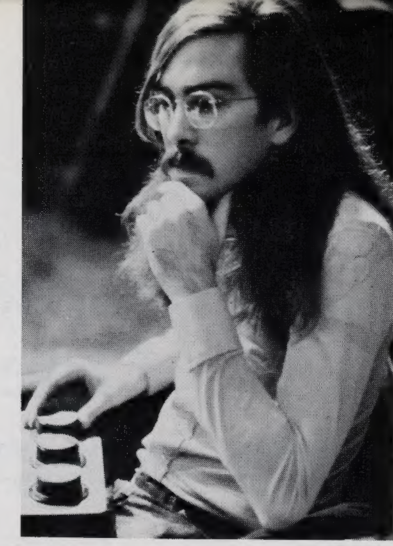
People Time Is More Valuable Than Computer Time. IBM has long disagreed with this, but technology is creeping on. As Tom says, "One shouldn't have to do the same thing twice just to save the computer some work." Many computer systems require people to do things over and over in a very tedious way because users have no way to build new sequences from parts of old ones.

Use The Advantages of Both Digital and Analog. Digital processes are scientifically accurate, combine easily and can be changed and stored readily, but they require a program to produce results. Analog is easier to control in a human manner and gives speed and continuity advantages.

Multilevel Allows Room For Both Personal and Technological Growth. If a new user can begin working on a system and get results, yet even after years of experience continue to find new creative possibilities, the device is multi-level from a human standpoint. If the system allows integration of new technology, this is also an aspect.

How do these components work together to produce a time-effective educational tape program? Let's briefly look at the process.

A user (who can be an educator, artist or student) has an idea he or she wants to see on a program to be built. The first step is to sit down at the keyboard and begin to type into the computer the three-dimensional coordinates of the visuals. The lines between these points appear instantly on the screen of the Victor General. Instant changes can be made and the process continues until the image is right or the movement sequence is correct. Meanwhile the black-and-white cameras are focused on the VG screen and the signals are fed through the image processor where they are colorized, modified, combined, and so forth by connecting cables and setting dials. When all is correct, the signals are recorded. Audio can be added in a standard way. Other video can be edited in and the procedure then becomes a standard production process.


Tom DeFanti at the dials.

The procedure sounds simple, and it is, but there is so much more there than can be described in words. The accompanying pictures contain only a tiny fraction of the information and effects. The movement, the interrelations, the form and pattern give visual meanings that can only be fractionally captured in even the best still photography. In fact, Dan built the image processor because "the free expression and play I needed were too slow and cumbersome in film."

A number of tapes have been produced by the system. These include programs in chemistry, geology, mathematics, medicine and computer programs. Dan and Tom practice what they preach. There are a set of tapes on how to use both systems.

It's difficult to fully explain and demonstrate the system in print—so why not see what it can do for yourself? Demonstration tapes are available in U-matic format. You can call Dan and Tom in Chicago at 312-996-4631, or you can contact Larry Finley at the International Tape Association, 10 West 66th Street, New York, NY 10023.

Dan Sandin using the image processor in performance.